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Willingness to receive a hypothetical avian influenza vaccine among US military personnel in mid-deployment

Chad K Porter[1,]*, Gina Fitamaurice[2], David R Tribble[3], Adam W Armstrong[4], Manal Mostafa[5], and Mark S Riddle[1]

[1]Naval Medical Research Center; Enteric Diseases Department; Silver Spring, MD USA; [2]George Washington University; School of Public Health and Health Services; Washington, DC USA; [3]Infectious Diseases Clinical Research Program; Uniformed Services University; Bethesda, MD USA; [4]Walter Reed National Military Medical Center; Bethesda, MD USA; [5]United States Naval Medical Research Unit No. 3; Cairo, Egypt

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Though no avian influenza vaccine currently exists, development efforts have increased. Given recent reports of suboptimal vaccination rates among US military personnel, we sought to assess factors associated with a willingness to receive a hypothetical avian influenza vaccine. A self-administered questionnaire was completed by US military personnel during mid-deployment to Iraq, Afghanistan, and surrounding regions. Respondents were predominately male (86.2%), Army (72.1%), and enlisted (86.3%) with a mean age of 29.6 y. The majority (77.1%) agreed to receive an avian influenza vaccine if available. Exploratory factor analysis (EFA) identified two factors, vaccine importance and disease risk, that best described the individual perceptions and both were associated with an increased willingness to receive the hypothetical vaccine (OR: 8.2 and 1.6, respectively). Importantly, after controlling for these factors differences in the willingness to receive this hypothetical vaccine were observed across gender and branch of service. These results indicated that targeted education on vaccine safety and efficacy as well as disease risk may modify vaccination patterns in this population.

Introduction

Vaccination is a key component of primary prevention strategies for numerous infectious diseases and suboptimal vaccination rates have been associated with increased disease rates.[1-3] Nonetheless, vaccination rates for many vaccine-preventable diseases are sub-optimal and the factors driving these suboptimal rates are poorly understood.[4-11] Understanding the factors associated with sub-optimal vaccination rates may enable targeted education efforts to minimize those factors and improve vaccine coverage and subsequently lower disease incidence.

The United States military offers a unique population in which to study knowledge and attitudes about vaccines given their compulsory nature in this population. Prior studies in this population have identified a poor understanding of disease risk and severity as well as concerns over vaccine safety as key components in sub-optimal predeployment vaccination rates despite receipt requirements.[8,9,12,13] Interestingly, research thus far has focused on currently available vaccines without an eye toward the development of novel vaccine candidates that may become available in the near future. A vaccine against H5N1 is one such candidate that may be recommended for a subset of service members deploying to at risk regions.[14,15] Given the US military's efforts in influenza surveillance[16,17] and the pathogens potential importance to military populations, we sought to assess factors associated with a willingness to receive a hypothetical avian influenza vaccine and to conduct exploratory factor analysis to identify groups of questions that pointed to underlying factors.

Results

Between September 2007 and July 2008, 1762 US service members completed a questionnaire and responded to the primary outcome assessing whether or not they would receive an avian influenza vaccine if one existed (**Fig. 1**). As shown in **Table 1**, respondents were predominately male (1468, 83.4%), in the Army (1257, 71.4%), of enlisted rank (1541, 87.8%) and on regular duty status (1224, 69.7%) with a mean age of 29.1 (standard deviation: 8.3). Respondents agreeing and disagreeing with the statement "(i)f there were a vaccine against bird flu, I would take it" were more predominately male (χ^2, 2 d.f. = 9.10; p = 0.01) than those neither agreeing nor disagreeing. No other statistically significant differences in demographic characteristics across response categories to the primary outcome were observed.

A total of two factors were identified from 10 questions based on Cattell's scree test (see **Fig. 2**) and Kaiser's criterion with a

*Correspondence to: Chad K. Porter; Email: chad.porter@med.navy.mil
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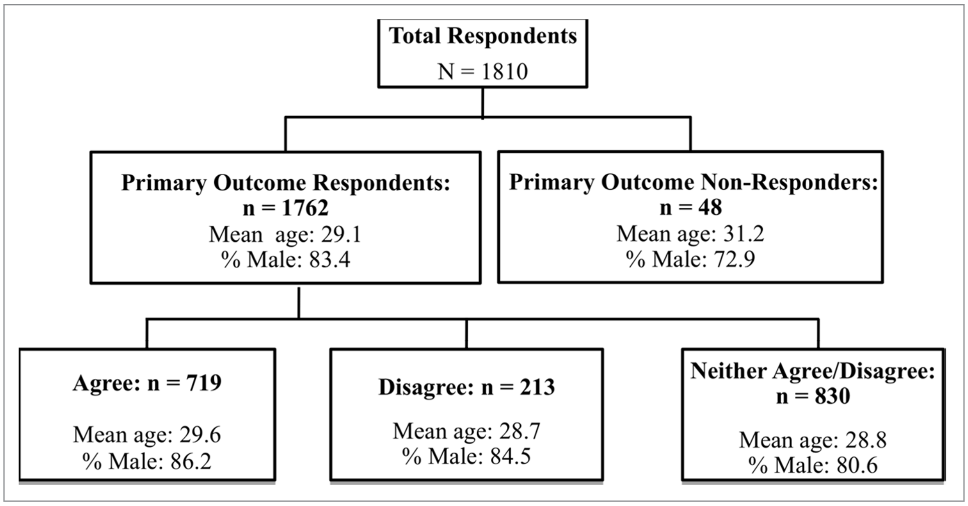

Figure 1. Study population.

cumulative variance of 1.16 and preliminary eigenvalues of 4.87 and 1.45. An additional question, "I believe information about pre-deployment vaccines from my friends" was excluded due to low factor loadings (<0.3) to the two identified factors (data not shown). The two factors explained 89.3% and 26.6% of the variance, respectively. Tucker and Lewis's reliability coefficient indicated good reliability (0.88).[18] Eigenvalues of the weighted reduced correlation matrix were 5.96 and 1.81 and the proportion of variance explained was 76.7% and 23.3%, respectively. The factor loadings for each survey question are shown in **Table 2**

Table 1. Summary of baseline demographic characteristics from survey by whether someone would agree to receive a hypothetical avian influenza vaccine from 2007–2008

	Agree	Disagree	Neither agree nor disagree
Mean age, (SD)	29.6 (8.5)	28.7 (8.5)	28.8 (8.0)
Gender, n (%)			
Male	620 (86.2)	180 (84.5)	668 (80.5)
Female	99 (13.8)	33 (15.5)	161 (19.4)
Military branch, n (%)			
Army	518 (72.1)	157 (73.7)	582 (70.2)
Air Force	40 (5.6)	6 (2.8)	38 (4.6)
Marine Corps	68 (9.5)	20 (9.4)	105 (12.7)
Navy	92 (12.8)	29 (13.6)	101 (12.2)
Other	0 (0.0)	1 (0.5)	3 (0.4)
Rank, n (%)			
E1-E4	337(46.9)	105 (50.0)	388 (46.9)
E5-E6	232 (32.3)	67 (31.9)	290 (35.0)
E7-E9	44 (6.1)	14 (6.7)	64 (7.7)
Officer	105 (14.6)	24 (11.4)	86 (10.4)
Duty status, n (%)			
Regular	493 (68.7)	155 (72.8)	576 (69.7)
Reserve	104 (14.5)	24 (11.3)	127 (15.4)
National Guard	119 (16.6)	31 (14.6)	123 (14.9)
Other	2 (0.3)	3 (1.4)	0 (0.0)

and reflect two underlying themes, vaccine safety/efficacy and disease risk. These were subsequently termed, "Vaccine Factor" and "Disease Factor".

Univariate and multivariate analyses were conducted to determine demographic characteristics and factors associated with agreement to the question "If there were a vaccine against bird flu, I would take it." There was no association between the agreement with the bird flu question and prior deployments, military component (reserve, national guard, regular, other) or rank (data not shown). After controlling for gender and branch of service, the two identified factors were associated with willingness to receive a hypothetical avian influenza vaccine (**Table 3**). Specifically, those who more commonly agreed that vaccines were safe and effective were over 6 times more likely to agree to vaccination compared with those who did not. Similarly, those more concerned about disease risk and severity were 1.3-fold more likely to agree to vaccination than those expressing less concern.

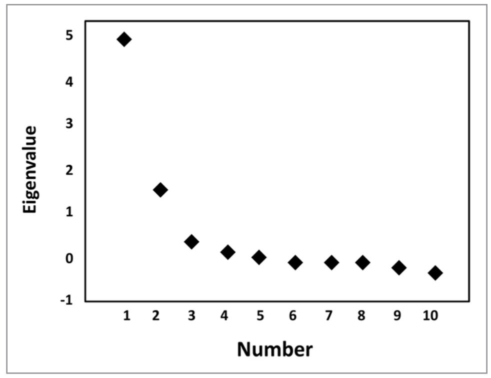

Figure 2. Scree plot of eigenvalues by number of potential factors. The Scree plot indicates that only two factors are needed to explain the majority of the variance in responses to the ten solicited questions.

Discussion

This study supports prior findings indicating that vaccine safety and disease risk are important factors in hypothetical vaccination compliance among military populations despite the compulsory nature of vaccines in this population.[8] Furthermore, despite both factors being associated with an increased willingness to receive the hypothetical vaccine, the "Vaccine" factor showed the greatest strength of association highlighting the importance of perceived vaccine safety and efficacy regardless of perceived disease risk.

This study is not alone in identifying perceived disease risk and vaccine safety and efficacy as important drivers of vaccination in military populations. Most recently, Polak et al. noted that among a deployed force, 17.1% of respondents would decline vaccinations if given the opportunity; an observation that was associated with concerns of vaccine safety and low perceived disease risk.[8] Similarly, when focusing on anthrax vaccine uptake in military personnel, the lone factor significantly associated with vaccination rejection was perceived vaccine safety.[13] While neither those studies nor this one likely capture all elements inherent in the decision factors, they clearly point to two main themes as areas for potential targeted education for existing and future vaccines.

In addition to our observations of the importance of vaccine perceived safety and disease risk on vaccine willingness to receive a hypothetical vaccine, we also noted that males were reported to be significantly more likely to receive the hypothetical vaccine than females. This is not the lone study to report this observation. For example, Bohmer reported that male healthcare workers in Germany were more likely to be vaccinated against seasonal influenza than were their female counterparts.[19] However, this finding is not universal. Zingg and Siegrist, developing a one dimensional scale to identify factors associated with self-reported decreased vaccination rates, found no effect of gender.[12] Our study population is clearly a unique subset of the general healthy US population and may have unique perspectives regarding vaccine safety and, in a compulsory environment is likely to be influenced in ways dissimilar to the general population. Furthermore, in our brief survey, we intentionally did not capture all potential demographic characteristics that may influence willingness to receive a hypothetical vaccine. Exclusion of these factors may have resulted in our ability to appropriately control for other demographic characteristics which may have been disproportionally allocated to one gender in our population sample.

We also observed differences in vaccination willingness across branch of service with Marines reporting a lower likelihood of vaccine receipt than other branches of service. This is not the only study to identify branch-specific differences in vaccine knowledge and attitudes.[13] These differences may reflect true differences across the branches of service associated with the education or training across branches, or, more likely, may reflect underlying differences in the characteristics of individuals serving in the different branches of the military.

Few other studies have attempted to identify principal factors associated with vaccination uptake and/or willingness to be vaccinated. Specifically, using a questionnaire based on Health Belief Model constructs, Gowda et al. identified three factors, harms/ineffectiveness, barriers and social norms, associated with maternal perceptions of HPV vaccination and vaccine uptake and/or future intent to vaccinate.[20] The authors showed that as general support for vaccines decreased, the likelihood of vaccination decreased. This observed effect was strongest for the factor titled 'Harms/Ineffectiveness' similar to our observation that the perceived safety and efficacy of vaccines increased, so did the likelihood of vaccination. Similarly, and perhaps more directly comparable to our study, determinants of seasonal influenza vaccination among elderly populations have repeatedly identified perceived influenza risk and vaccine side effects as factors directly associated with vaccine uptake.[21] Importantly, these populations are distinct not allowing direct comparisons. One of the most obvious differences is that vaccinations are compulsory in the military and all active duty personnel have free, relatively unfettered access to care removing many barriers that were associated. As such, our questionnaire excluded potential barrier-related questions. Additionally, the demographics of the study

Table 2. Mean values and factor loadings for survey questions

	Mean (SD)	Vaccine factor	Disease factor
Pre-deployment vaccines are safe	2.54 (0.8)	**0.83**	-0.04
Pre-deployment vaccines will protect me	2.65 (0.8)	**0.77**	0.03
I want people I care about to get vaccines	2.85 (0.9)	**0.67**	0.03
I believe information about pre-deployment vaccines from my command	2.41 (0.9)	**0.65**	0.05
I believe information about pre-deployment vaccines from my doctor	2.83 (0.9)	**0.64**	0.05
I am at risk for diseases that I am vaccinated for	1.26 (1.2)	-0.09	**0.58**
Diseases can be deadly	2.33 (1.2)	0.12	**0.50**
Diseases cannot be treated effectively by medicine	1.77 (1.0)	-0.05	**0.55**
If I am exposed to a germ, I will get sick	2.09 (1.1)	0.07	**0.50**
I can get the disease from the vaccine	1.76 (0.9)	-0.21	**0.37**
Factor score mean (SD)*		2.66 (0.7)	1.81 (0.6)
Cronbach's α		0.84	0.62

All items used a 5-point scale: strongly agree/always,[4] agree/usually,[3] neither agree nor disagree/sometimes,[2] disagree/rarely,[1] strongly disagree/never (0). The bolded factor loadings were utilized to group into two factors. *Calculated as a mean of the likert scale responses (0 to 4) to questions with a primary loading onto that factor; the higher value indicates increased agreement or frequency.

population are markedly different in that military populations are relatively young and predominately of male gender which further confounds direct comparisons.

Though this survey instrument was pre-validated in a small sample prior to this survey and a large number of respondents were analyzed, limitations exist. A significant proportion (47.1%) of respondents reported neither agreeing nor disagreeing with the primary outcome question. This proportion is higher than what has been reported in a prior study in this population and may be the result of central tendency bias or respondents unwillingness to state disagreement with a willingness to receive a vaccine in a compulsory environment.[8] Other limitations are inherent in exploratory factor analysis including the identification of the number of factors. Some have argued that the Kaiser method of factor retention overestimates the number of factors that should be retained and does not account for the fact that some eigenvalues may fall just above or below one.[22] Furthermore, the scree plot may suffer from ambiguity and subjectivity when no clear break or "elbow" is apparent in the plot.[22] Despite these criticisms, two factors with relatively high factor loadings, clearly distinct from one another, were retained and seem to represent important drivers of vaccination.

Clearly, the results of this study should be confirmed in similar populations using a confirmatory factor analysis to assess consistency in these findings. Furthermore, while the factors associated with an increased willingness to receive a hypothetical avian influenza vaccine may ultimately prove important, actually measuring documented receipt of more routine vaccinations and the factors associated with their receipt may have greater public health importance and allow for the development of more targeted educational efforts enhancing vaccine uptake. Nonetheless, these results highlight two main factors, disease risk and vaccine safety that appear to be discrepant between willing vaccine recipients and those that are more resistant.

Methods

Data were obtained from a 2007–2008 cross-sectional study in which a single-page self-administered questionnaire was given to a convenience sample of United States military personnel as described previously.[8] Briefly, subjects were participating in in-theater rest and recuperation at Camp As Sayliyah in Doha, Qatar or transiting Incirlik Air Base in Turkey in route to the US out of theater.[8] Participants, in mid-deployment to

Table 3. Demographic characteristics and factors associated with increased willingness to receive a hypothetical vaccine against avian influenza[a]

	Univariate OR (95% CI)	Multivariate OR (95% CI)
Male	1.43 (1.10, 1.86)	1.63 (1.21, 2.19)
Service in Marine Corps	0.77 (0.56, 1.05)	0.64 (0.45, 0.92)
Vaccine factor[b]	5.97 (4.88, 7.32)	6.38 (5.19, 7.85)
Disease factor[b]	1.20 (1.04, 1.38)	1.33 (1.12, 1.57)

[a]Determined by those responding strongly agree or agree to the question "If there were a vaccine against bird flu, I would take it." [b]Calculated as a mean of the Likert scale responses (0 to 4) to questions with a primary loading onto that factor.

parts of Africa, the Middle East, and Iraq, responded to 21 questions regarding demographic characteristics, perceptions, beliefs, and attitudes toward receipt of a hypothetical avian influenza vaccine.

Questionnaire data were entered into Microsoft Excel (Microsoft Inc.) and SAS 9.2 (SAS Institute) was utilized for statistical analyses. Likert scale responses to the primary outcome variable were dichotomized to either "agree" (subject would receive a hypothetical avian influenza vaccine) or "disagree" (subject would not receive this vaccine). Similarly, 5-level Likert responses for dependent variables were collapsed into "agree," "neither agree nor disagree", and "disagree." Demographic comparisons were made using the Student t-test and chi-square test procedures for continuous and categorical variables, respectively. An exploratory factor analysis (EFA) was conducted on questions assessing attitudes, perceptions, and beliefs toward pre-deployment vaccines using the maximum likelihood method for factor extraction and the Kaiser method as well as Cattell's scree plot method of factor retention.[23,24] Briefly, exploratory factor analysis assesses how a group of correlated variables may be able to be grouped into a smaller number of variables. Cronbach's (α) coefficient was used to evaluate the internal reliability of each factor grouping.

Factor scores were calculated using the mean of the variables loaded onto that factor. A logistic regression model was developed to assess the association between factor scores and willingness to receive a hypothetical avian influenza vaccine while controlling for important covariates.

This study was approved by the institutional review board at the Naval Medical Research Unit No. 3 (NAMRU3), Cairo, Egypt.

Disclosure of Potential Conflicts of Interest

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, nor the US Government. This is a US Government work. There are no restrictions on its use. There were no financial conflicts of interests among any of the authors. This study was conducted under support of the Military Infectious Disease Research Program and Department of Defense Global Emerging Infections Surveillance and Response System funding.

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